

PATENT SPECIFICATION



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195,050

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Complete Accepted : July 19, 1923.

COMPLETE SPECIFICATION.

Improvements in Steam Turbine Blades, and in the Method of Manufacturing such Blades.

We, AKTIENGESELLSCHAFT BROWN BOVERI & CIE., of Baden, Switzerland, a Swiss company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The ever increasing steam velocities employed in modern turbine construction entail very grave drawbacks owing to the great wear of the blades which is noticeable above all, in the low pressure portion of the turbine, that is to say, in the stages where there is a partial condensation of the steam.

This wear is mainly due, not to corrosion, but to erosion, namely, the small drops of water formed in the steam impinge with a very high velocity upon the blades and thereby cause mechanical erosion of the latter.

The erosion occurs chiefly at the edges of the blades and at those parts of the blades that are immediately adjacent to the said edges. Likewise, the erosion is considerably greater on the outer parts of the blade than on the inner parts, as approximately indicated in Figure 1 of the accompanying drawings.

In order to obviate this erosion it is desirable to employ as hard a material as possible which is not eroded, or only very slightly eroded, by the water drops. On the other hand however, the use of such a material for blades is quite undesirable for reasons of strength, because blades of hard material are subject in the highest degree to the risk of breakage, whereby reason of water hammer, sudden acceleration and retardation, the blades become scored, and consequently increased strains come into question. Also by reason of fatigue, due to vibration, the resistance of the blades

is considerably smaller than that of of blades made of softer and tougher material.

It has been proposed to surround turbine blades with an outer protective sheathing, or to add to a blade a replaceable edge of specially resistant material. It has also been proposed to weld a protective sheathing to such blades.

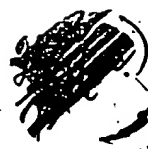
The present invention consists in combining the advantages of hard and soft materials and avoiding the respective drawbacks of such materials, by making each blade in one piece from a tough material, and hardening by case-hardening or otherwise, those parts which are exposed to the greatest erosion.

The application of the improved method is favoured by the fact that the outer portions of the blade which, as shown in Figure 1, are most exposed to erosion, are least strained by centrifugal and bending forces, and can therefore be hardened without prejudice to their strength, for instance as indicated by hatchings in Figure 2. Hardening of the whole of the edges, as shown in Figure 3, has comparatively very little effect upon the strength of the blade, because the edges constitute only comparatively small and not very strong parts of the section as indicated in Figure 4, where the hardened portions are shown black. This hardening in parts has the further advantage of leaving the head of the blade soft which is utilised for rivetting the end ring, as indicated at *a* in Figure 3.

One way of carrying this invention into effect consists in employing a material which of itself cannot be hardened, and coating this material at the places where it is not to be hardened, with, for instance, an electrolytic deposit which

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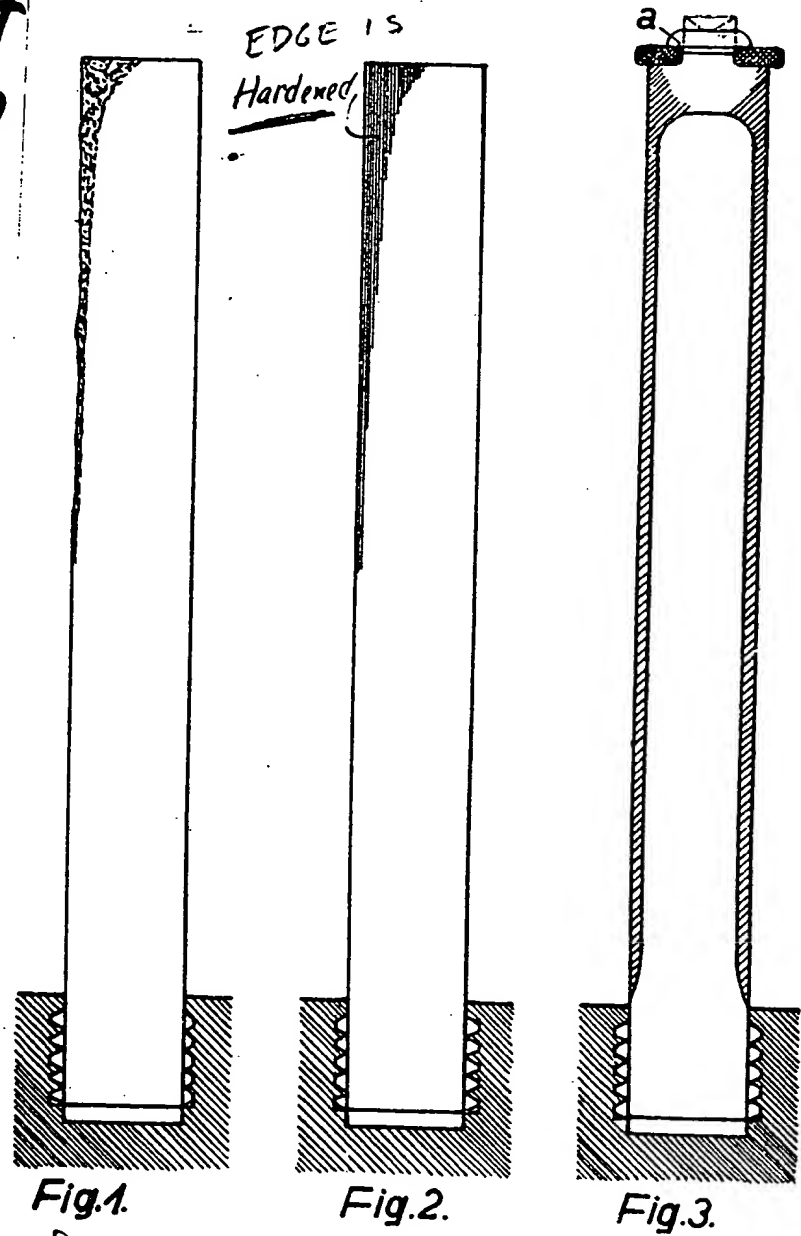


Fig.1.

Fig.2.

Fig.3.

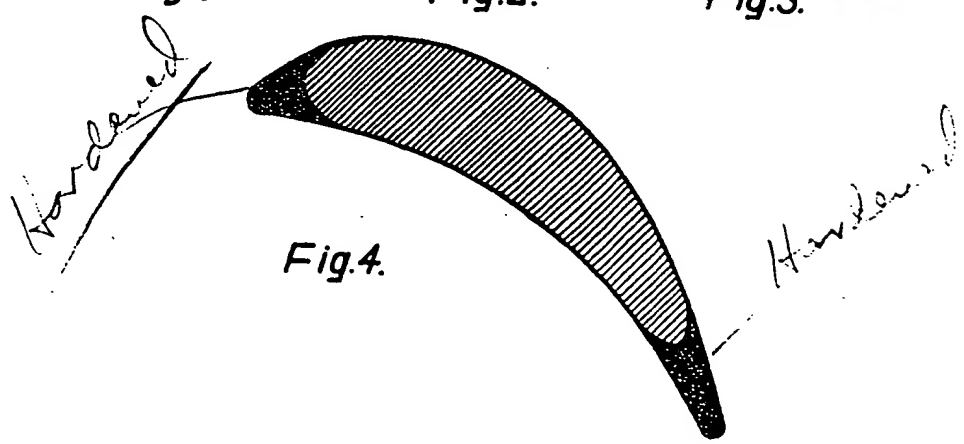


Fig.4.

[This Drawing is a reproduction of the Original on a reduced scale]

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does not allow any carbon to penetrate, and then, by a case-hardening operation, enriching the non-coated, that is to say, unprotected places with carbon, and then hardening such places by subsequent quenching. The blade may also be hardened as a whole and softened at those parts which are not required to be hard.

- 10 In order to prevent the blades from being distorted by this partial hardening, or to prevent injurious effects of such distortion, the blade, before quenching, may be clamped in a rigid mould, or be
15 bent in the opposite direction, in such a manner that the distortion due to the hardening will cause the blade to become straight again.

Having now particularly described and
20 ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A steam turbine blade characterised
25 by the feature that it is constructed in one piece and hardened only in those parts which are most exposed to erosion, that is to say, more particularly at the upper part of the leading edge of the
30 blade, by variation of the proportion of hardening agent and its distribution.

2. A method for the manufacture of a blade as claimed in Claim 1, characterised by the feature that those parts of the hardened blade which are to remain
35 soft are softened again by tempering after the hardening.

3. A method for the manufacture of a blade as claimed in Claim 1, characterised by the feature that the blade is
40 made of a material which is not capable of being hardened of itself, and is hardened by case-hardening after the portions that are not to be hardened have been protected from penetration by
45 carbon, by means of an electrolytic or similar coating.

4. A method for the manufacture of a blade as claimed in Claim 1, characterised by the feature that parts which
50 are to be machined subsequently (such as for instance, the blade head to be rivetted) are left unhardened.

5. The improved manufacture of steam turbine blades, substantially as herein
55 before described.

6. As a new product of manufacture, an improved blade for steam turbines, constituted and treated substantially as
60 hereinbefore described.

Dated this 10th day of January, 1923.

MARKS & CLERK.